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A STUDY OF AIR QUALITY IN ASHEVILLE, NORTH CAROLINA, JANUARY 30 - FEBRUARY 5, 1963

North Carolina State Board of Health
Raleigh, North Carolina

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IN

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A Cooperative Study

by

City of Asheville

Buncombe County Health Department

North Carolina State Board of Health

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Introduction

Asheville is located on a plateau of elevation 2,300 feet in the Blue Ridge Mountains of Western North Carolina. This plateau is surrounded by mountain peaks to the north, east, and south.

With a population of 60,192, Asheville is the largest city in the Mountain Region of the State. It is in the center of the scenic mountain region known as "The Land of the Sky", embracing the entire western extremity of North Carolina and is the eastern entrance to the Great Smoky Mountains National Park.

Asheville is primarily noted as a summer resort and the center of tourist attractions. Because of this, air quality is one of the resources under close scrutiny by local residents as well as tourists.

The City passed its first air pollution control ordinance in October, 1946. This ordinance was amended and revised in 1950 and rules and regulations were set forth under authority of this ordinance in March 1952 and April 1954. This ordinance delegates administrative and enforcement authority to the chief smoke regulation engineer and defines the duties of the Department of Smoke Regulation. It provides for regulation of sales, installation, and maintenance of solid fuel burning devices, prohibits emission of smoke in excess of No. 3 Ringlemann with certain exceptions, and prohibits emission of dust in the combustion gases in excess of 0.85 pounds per 1,000 pounds of gases, adjusted to 12 per cent carbon dioxide content. It requires that permits be secured for fuel burning devices, sets fees, prescribes penalties for violations, and provides for entrance to premises. An advisory board and appeal board are provided for in the Ordinance.

With many handicaps, the Department of Air Pollution Control has been very active and has done an exceptional job in carrying out its functions. The Department conducts annual inspections of equipment as well as supervises the installation of all new heating equipment. Schools for training furnace operators are conducted each year.

Even though Asheville is not heavily industrialized, air pollutants are released to the air from the combustion of fuels for heating, commercial and industrial processes, automobile exhausts, as well as from other general population activities.

This study of air pollution was made as a part of a long term program of the North Carolina State Board of Health in cooperation with local health departments and municipal air pollution control departments to evaluate air quality in North Carolina. This study was made jointly by the Sanitary Engineering Division of the North Carolina State Board of Health, Buncombe County Health Department, and the City of Asheville's Department of Air Pollution Control.

SUMMARY OF RESULTS

Because of the many variations in topography, prevailing wind speed and direction in the Asheville area, the results obtained by this short-term comprehensive study should only be considered indicative of the magnitude of air pollutants. Other areas of the City, due to their location, the time of the year or prevailing weather conditions, may certainly have higher or lower levels of air pollutants than were found during this study.

Results of this seven-day study may be summarized as follows:

1. The levels of air pollutants found indicate that Asheville has a profound air pollution problem.
2. The levels found for soiling capacity and particulate matter indicate the presence of a very pronounced smoke problem.
3. The high concentration of sulfur dioxide was found to greatly exceed the concentration to cause plant damage. This occurrance appeared for only a short period of time.
4. The visibility standard for ambient air was exceeded four of the seven days of the study. The standard for particulate matter is stated to be "adverse" when visibility is reduced to less than three miles when the relative humidity is less than 70 per cent.
5. A combination of meteorological conditions, including low wind speed, temperature inversion, and haze as noted on January 30, February 2, 4, and 5 appear to attribute greatly to the highest levels of general air pollution found for the entire sampling period.

6. The levels for some of the gaseous pollutants are about average and comparable to levels found in cities of comparable size as Asheville; however, under conditions of low wind speed and temperature inversion, the levels may accumulate until much higher levels are reached.

RECOMMENDATIONS

Based on the results of this study, analysis of local meteorological data, and the present technical knowledge of the growing problem of air pollution, it is recommended that the City of Asheville:

1. Expand the present program to provide for far more effective control of air pollution.
2. Revise the current "Ordinance Relating to the Emission of Smoke and the Pollution of Air, Prescribing Methods of Enforcing Penalties, and Declaring an Emergency" to include the control of open fires, fuel quality, and other recognized factors affecting air pollution.
3. Implement the present air pollution program by sampling particulate and gaseous pollutants to further delineate the problem and for surveillance of pollutional levels.
4. A public education program for the dissemination of air pollution information and the development of community action and support for effective air pollution control.

CONDUCT OF STUDY

The study was planned to provide intensive air pollution sampling for seven consecutive days, January 30 through February 5, 1963, including one weekend and one all-night sampling period. The gaseous and particulate pollutants under test were selected to be indicative of the general levels of air pollution.

This study was conducted from the second floor roof of the City of Asheville's Police Department and Fire Station where the Laboratory Division of the Buncombe County Health Department is located thus making the facilities of the laboratory available. This site is centrally located in the downtown area.

THE TESTS

Sampling was done for gaseous as well as particulate matter in the area. Gaseous constituents included oxidant, nitric oxide, nitrogen dioxide, carbon monoxide, sulfur dioxide, and hydrogen sulfide. These gaseous pollutants were collected by passing known quantities of outside air through liquid chemical solutions, chemically impregnated granules or tapes. Oxidants samples were collected for ten-minute periods every two hours. Nitric oxide, nitrogen dioxide, and sulfur dioxide samples were collected for fifteen minute periods every two hours. Carbon monoxide samples were collected for a thirty-minute period every two hours. Hydrogen sulfide was collected with a sampler that drew a metered amount of outside air (about 0.2 cfm) through a lead acetate impregnated filter tape. These samples were collected continuously with two-hour sampling periods. Soiling capacity was measured with an AISI sampler that drew a

meter quantity of outside air through a special filter paper. The sampler was operated continuously with two-hour sampling periods. Suspended particulate matter was collected on a glass fiber filter by means of a High Volume Sampler. These samples were collected for twenty-four hour periods.

Details concerning these measurements are as follows:

Pollutants	Primary Sources	Method
Oxidant	Photochemical	Phenolphthalin
Nitrogen Dioxide (NO_2)	Combustion Processes and Motor Vehicles	Saltzman
Nitric Oxide (NO)	Combustion Processes and Motor Vehicles	Saltzman
Carbon Monoxide (CO)	Combustion Processes and Motor Vehicles	NBS Detector Tube Technique
Sulfur Dioxide (SO_2)	Combustion of Sulphur containing fuels and industrial processes	West
Hydrogen Sulfide (H_2S)	Industrial Processes	AISI with lead acetate tape
Particulate Matter	Combustion Sources, Motor Vehicles, industrial processes and other dusts	(1) AISI sampler (2) High Volume Sampler

DATA

Maximum Pollution Levels: Table 1 lists the maximum levels of pollution which were found during the survey.

The maximum levels of sulfur dioxide, smoke and particulate matter are indicative of an air pollution problem. The maximum level of oxidant occurred on February 4 when the level reached 0.10 ppm. This is less than one-half the level of 0.25 ppm. at which some people experience eye irritation. Air pollution standards for ambient air as set forth by the California State Department of Health is approximately equivalent to 0.30 ppm. for one hour for oxidants by the phenolphthalin method as used in this study. Therefore, the oxidant standard was not exceeded during the study.

The maximum level for the oxides of nitrogen reached a level of 0.90 for nitric oxide and 0.30 for nitrogen dioxide, occurring on January 30 and 31. These levels are comparable to the levels reached on smoggy days in the Los Angeles area and as has been found in the Washington, D. C. area.

The maximum level of sulfur dioxide was 1.2 ppm. and was reached on February 4 which greatly exceeds that found in many large population centers. This maximum level of sulfur dioxide exceeds the 0.3 ppm. level which is known to cause damage to plants during an 8-hour exposure or the 1.0 ppm. level which will cause such damage in 1 hour.

Figures 1 and 2 show the parallel variations for the maximum daily gaseous and particulate pollutants together with the average daily wind speed. Pollution levels for both gaseous and particulate pollutants are related to meteorological conditions such that increased levels are noted with a decrease in the average daily wind speed. This pattern is

particularly noted on February 4 as well as on January 30 and February 2. A combination of meteorological conditions, such as low wind speed and a temperature inversion, caused these elevated levels of air pollution. During these morning periods, a definite haze layer or smog existed over the City while clear weather and unlimited visibility existed outside the tunnel areas and across the mountains surrounding the City. This condition may be further demonstrated by the visibility measurements given in Table 1. Ground level inversions occur at rather frequent intervals in this area.

During periods of ground level inversions, it should be noted that pollutant levels increased rather significantly: the nitrogen dioxide and nitric oxide levels increased from 0.03 to 0.08 and from 0.07 to 0.4 parts per million respectively; the sulfur dioxide increased from 0.06 to 1.20 parts per million, a very significant increase; the soiling index more than doubled during these periods. It should also be noted that all of these increases occurred during the morning hours at the time of greatest ground level inversion. However, following changes in meteorological conditions, the levels decreased and returned to near normal. This is an indication that gaseous and particulate pollutants may accumulate to high levels during periods of low wind speed or temperature inversion that persist for several hours or several days.

Although the study included sampling for carbon monoxide (CO) and hydrogen sulfide (H_2S), concentrations were very small. Carbon monoxide reached a maximum of 2.0 ppm. on February 4. The hydrogen sulfide ranged from below detectable concentrations to a maximum of 0.004 ppm. It is probable that higher concentrations of hydrogen sulfide would be found in certain areas of the City where industrial processes discharge effluents containing this waste product.

Smoke Concentrations: Table 2 gives the complete smoke sampling results for the respective two-hour sampling periods during the seven-day study period. Smoke concentrations reached peaks during the morning hours, then decline during the remainder of the day when atmospheric dispersion is greatest. Pollutants again rise to a second peak in the early night hours, then again decrease in the early morning hours. This trend is associated with two factors: first is the increased fuel combustion for heating during the morning for industrial, commercial, and residential facilities, and secondly, the strong early morning temperature inversions. The combination of these effects means more pollution in the area with less dispersion or diffusion to the atmosphere.

Table 3 gives selected meteorological variables. Atmospheric stability measurements were not available during this period.

TABLE 1

MAXIMUM POLLUTION LEVELS

ASHEVILLE, NORTH CAROLINA January 30-February 5, 1963

Date	Oxidant ppm	NO_2 ppm	NO ppm	Soiling Index Cohs/1000 l.f.	CO ppm	SO_2 ppm	Particulate* Matter ug/cu. M.	Visibility** miles Minimum	Relative** Humidity %
Wednesday, January 30	0.03	0.30	0.35	7.9	1.25	0.07	---	3.0	80
Thursday, January 31	0.08	0.08	0.9	5.0	1.25	0.06	109	15+	72
Friday, February 1	0.06	0.08	0.15	4.2	1.00	0.06	115	0.5	96
Saturday, February 2	0.03	0.08	0.25	8.8	1.5	0.19	140	0.5	90
Sunday, February 3	0.03	0.03	0.07	6.0	---	0.06	119	---	47
Monday, February 4	0.10	0.08	0.4	12.	2.0	1.20	172	---	38
Tuesday, February 5	0.08	0.08	0.31	8.1	---	0.13	148	15+	41

* Sampling period from 9 A. M. to 9 A. M. and is reported on day filter removed.

** U. S. Weather Bureau, Asheville, North Carolina.

FIGURE I. DAILY MAXIMUM LEVELS FOR PARTICULATE AND SULFUR DIOXIDE WITH AVERAGE DAILY WIND SPEED

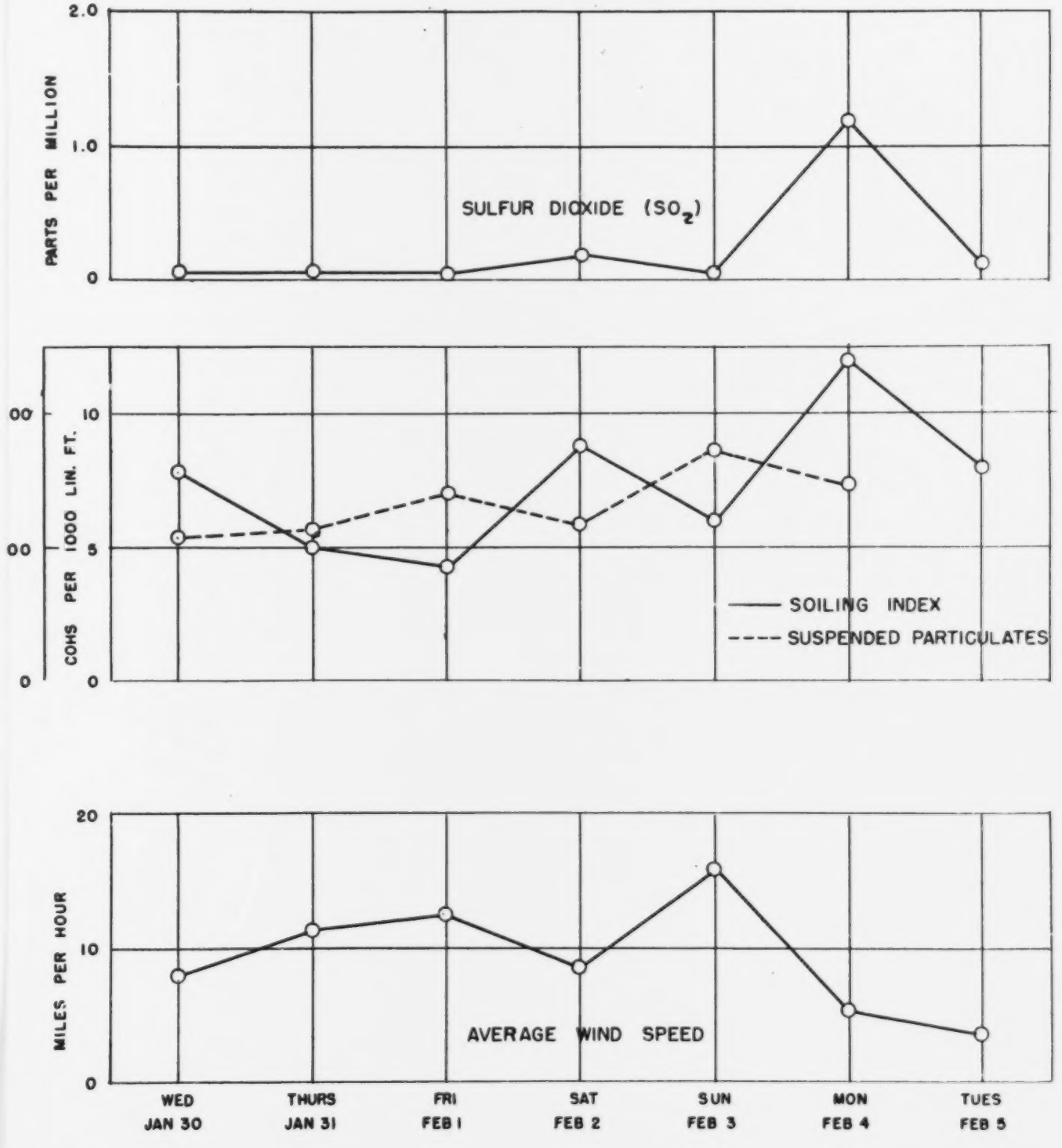

FIGURE 2. DAILY MAXIMUM LEVELS FOR OXIDES OF NITROGEN AND OXIDANT WITH AVERAGE DAILY WIND SPEED

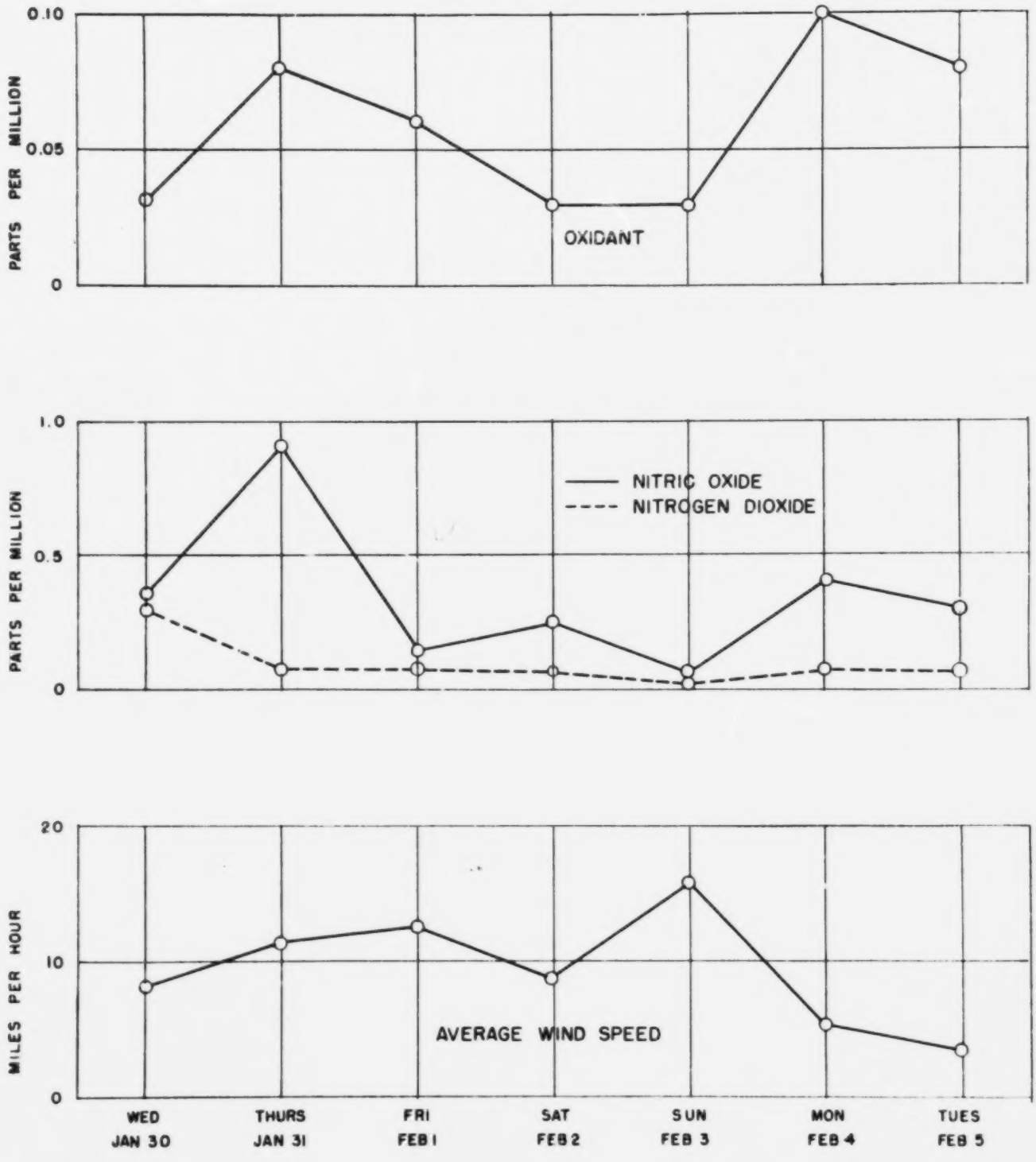

TABLE 2

SMOKE CONCENTRATIONS

Soiling Index - Cohs/1000 Linear Feet

	12-2	2-4	4-6	6-8	8-10	10-12	12-2	2-4	4-6	6-8	8-10	10-12	Avg.	Max.
Wednesday, January 30	1.6	2.9	3.7	5.0	7.9	5.0	4.7	3.9	3.9	3.5	3.7	3.7	4.1	7.9
Thursday, January 31	2.9	2.0	1.4	3.4	3.3	3.2	2.8	2.9	2.9	5.0	2.0	1.4	2.7	5.0
Friday, February 1	1.4	1.0	2.0	3.2	4.2	1.8	2.3	3.4	3.2	4.2	3.4	2.7	2.7	4.2
Saturday, February 2	1.6	1.4	4.7	5.7	6.7	8.8	8.3	7.9	6.7	2.0	2.0	2.3	4.8	8.8
Sunday, February 3	2.0	1.6	2.2	2.8	2.7	2.0	2.0	2.0	2.7	3.2	3.2	6.0	2.7	6.0
Monday, February 4	4.5	2.9	7.5	12.1	8.3	2.9	2.9	0.6	0.2	1.3	4.1	5.0	4.3	12
Tuesday, February 5	6.3	---	---	8.1	7.5	3.5	3.5	2.2	3.7	4.2	7.9	7.5	5.4	8.1
Average	2.9	1.9	3.4	5.7	5.8	3.9	3.8	3.6	3.3	3.3	3.7	4.0		
Maximum	6.3	2.9	7.5	12.1	8.3	8.8	8.3	7.9	6.7	5.0	7.9	7.5		
Minimum	1.4	1.0	1.4	2.8	2.7	1.8	2.0	0.6	0.2	1.3	2.0	1.4		

TABLE 3

SELECTED METEOROLOGICAL VARIABLES FOR JANUARY 30, 1963 THROUGH FEBRUARY 6, 1963,

FROM U. S. WEATHER BUREAU DATA, ASHEVILLE-HENDERSONVILLE AIRPORT

Date	Max. Temp. oF	Min. Temp. °F	Wind			Total Minutes Sunshine per Day	Min. Visibility in miles when rel. humidity less than 70%	Per Cent Relative Humidity at Time of Min. Visibility
			Ave. Speed MPH	Max. Speed MPH	Direction of Max. Speed			
Wednesday, January 30	56	35	8.0	19	N	173	3	80
Thursday, January 31	50	31	11.3	18	SE	485	--	--
Friday, February 1	39	32	12.5	26	SE	0	1/2	46
Saturday, Feburary 2	45	33	8.8	26	NW	0	1/2	90
Sunday, February 3	37	29	15.9	26	NW	554	—	--
Monday, February 4	44	21	5.5	15	NE	633	—	--
Tuesday, February 5	56	26	3.7	9	N	580	—	--

INTERPRETATIONS AND COMPARISONS

The effect of combined meteorological conditions upon air pollution was clearly demonstrated by the rapid and pronounced increase of most pollutant levels during the period of low wind speed and temperature inversion as experienced on February 4. In fact, the pollution levels found during this period were the maximums for February 4 as well as the maximums for the entire seven-day period.

Comparisons are particularly appropriate for the following pollutants:

1. Oxidants rose to the level of 0.10 ppm. which is approximately one-half of the 0.25 ppm. level at which some people experience eye irritation. This 0.10 ppm. is one-third the level adopted by the California State Department of Health for ambient air.
2. The California standard for particulate matter is "adverse" when visibility is reduced to less than three miles when the relative humidity is less than 70 per cent. This standard was exceeded four of the seven days covered by the sampling period. A large portion of the particulate matter appeared to be smoke pollution.
3. The soiling index is considerably high, with all daily maximum values exceeding 4.0 cohs per 1000 linear feet. This is an indication that the air contains considerable amounts of suspended particulate matter.
4. The average level for suspended particulate matter is slightly above that found in other cities of similar size in the State.

5. The level for sulfur dioxide on February 4 exceeded the known value to cause damage to vegetation. A maximum of 1.2 ppm. was recorded on February 4 which exceeds the concentration of 1.0 ppm. for one hour or 0.3 ppm. for eight hours which is known to cause damage. It should be noted that this occurred during the period of low wind speed and temperature inversion.